

Configuring the agricultural platforms: farmers' preferences for design attributes

Designing the
AgTech
platforms

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Abstract

Purpose – Although growing Internet penetration in the hinterlands has attracted agribusinesses to promote digital platforms, farmers are sceptical about using them. The literature discusses agricultural platforms from the theoretical perspective of technological determinism, where the platforms are developed and promoted by firms in a top-down manner to be accepted by farmers. However, this approach results in poorly configured platforms with limited utility for farmers. It is evident from the existing literature that the mere creation of a platform business is not sufficient to guarantee adoption by users. Hence, this study explores how to make the agricultural platform more attractive for farmers.

Design/methodology/approach – The present study is based on a discrete choice experiment performed on 126 Indian farmers using agricultural platforms. The data were analysed using the conditional logistic regression method.

Findings – The study suggests that farmers expect government and cooperative entities to be also embedded with the platforms. Complementary features such as prompt service, competitive pricing and farm credit were identified as essential attributes. Further, the platforms should enable smallholders to trade farm produce by providing a mechanism for real-time online nudging and bargaining with buyers.

Research limitations/implications – The study is based on the applications of random utility theory. The research has utility for Agtech managers, cooperative institutions and agricultural policymakers.

Originality/value – This is one of the first studies focussing on agricultural platform design from the farmers' perspective. The study implies that incorporating preferred attributes can help practitioners configure platforms to benefit farmers with prospects concerning farm management decisions.

Keywords AgTech, Agricultural platforms, Design, Discrete choice experiment, Farmer preference

Paper type Research paper

1. Introduction

Agricultural platforms have emerged as an alternative to traditional business models in the contemporary agribusiness environment (Omulo and Kumeh, 2020; Pupek *et al.*, 2020). The research on agricultural platforms underscores them as network-based entities comprising complementors, lead firms and terminal users or beneficiaries. A few examples of farming platform complementors are tech developers, innovators, agricultural input manufacturers, farmers, cooperative organizations, logistics partners, farmer producer organizations, financial institutions, village-level micro-entrepreneurs, agricultural universities, bulk farm

JEL Classification — O30, O35, Q13, Q16

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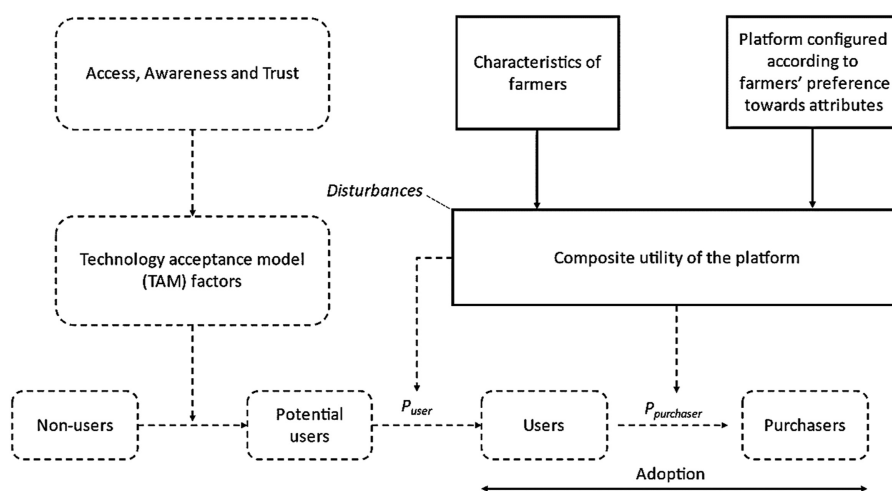
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produce buyers, research and local service providers (Cenamor, 2021; Cenamor and Frishammar, 2021; Ricart *et al.*, 2020; Singh and Kapoor, 2023). Despite the rising interest of agri-input firms, platform orchestrators and allied partner firms to enter and conquer the digital space, they face the challenge of attracting farmers to use the platform and perform business transactions (Mishra *et al.*, 2009; Omulo and Kumeh, 2020; Singh *et al.*, 2019). The challenge is more prominent in emerging markets like India, where most farmers are small and marginal with a risk-averse business attitude. The inability to onboard small and marginal farmers to perform business transactions has become a major stumbling block to the growth of the platform ecosystem in Indian agribusiness. The existing body of literature focuses on analyzing behavioural factors, technology acceptance models and socio-economic analysis to understand the platform's adoption by farmers (Al-Busaidi *et al.*, 2009; Batte and Ernst, 2007; Huo *et al.*, 2011; Jamaluddin, 2013; Kabbiri *et al.*, 2018; Mishra *et al.*, 2009; Omulo and Kumeh, 2020). However, the literature primarily discusses the platform from the theoretical perspective of technological determinism, where the agricultural platforms are developed and promoted by firms in a top-down manner to be later accepted by the farmers (Qureshi, 2014). However, this approach results in poorly configured platforms with lesser utility and suitability for the intended users. It is evident from the existing literature that the mere creation of a platform is not sufficient to exactly meet the need of the farmers and guarantee adoption (Fecke *et al.*, 2018; Jamaluddin, 2013; Mishra *et al.*, 2009; Omulo and Kumeh, 2020). In this backdrop, this study explores how to make the agricultural platform more attractive for the farmers.

The literature on socio-technical systems (STSs) indicates that the user preference-related approach has superseded the production-led approach (Baek *et al.*, 2015). This approach is also applicable to the development of agricultural platforms; hence the platform firms need to focus on designing the platforms from the farmers' perspective (Jarial, 2022). Marketing science scholars generally attempt to explore the consumers' perception of the value of the firm's offering (produce/services or, in our study, the platform itself) because users make the final purchase decision based on their perception of the costs and benefits of the offering (Barnard, 2016). Understanding the user's value perception of the firm offering must be integrated with its design and development process. Scholars typically use attributes to gauge the user's understanding of the offering (Kazan *et al.*, 2018). Based on this, we conjecture that the agricultural platforms can be considered a bundle of attributes (Fecke *et al.*, 2018). The farmer may attempt to simplify the decision-making process and choose between the alternative platforms based on the respective weight assigned to the attributes (Pingali *et al.*, 1997). While making the onboarding decision on a platform, the farmers compare and contrast the platform attributes in terms of the attribute utility parameters (Fecke *et al.*, 2018; Petry *et al.*, 2022; Singh *et al.*, 2018). Therefore, it is interesting to explore the farmers' preferences towards the platform design attributes, which can improve the overall utility function of the platform for the farmers.

The existing literature predominantly uses the technology adoption model (TAM) to explain the adoption of platforms by farmers. However, adopters may constitute both the users and purchasers in agribusiness platforms. The user farmers may only use the discovery value proposition of the platform (price discovery). At the same time, the purchaser farmers conduct business transactions regarding the purchase of agri-inputs or the sale of farm produce. As shown in Figure 1, access to, awareness of and trust in the agricultural platform is essential to the farmers' intention to use (potential users) the platform (along with technology acceptance model antecedents). However, the final likelihood to adopt (P_{user} and $P_{\text{purchaser}}$) depends on the composite utility function that the farmers derive from the platforms. The utility function will depend on the farmer-specific factors and the individual utility that the farmer associates with the platform attributes (Walker and Ben-Akiva, 2002).



Source(s): Adapted from (Gefen *et al.*, 2003; Hanna, 2018; Joshi and Islam, 2018; Walker and Ben-Akiva, 2002) and modified by authors

Figure 1.
The conceptual
framework

Based on this conceptual background, we ask two fundamental questions.

RQ1. What is the preference structure of the farmers towards the agricultural platform attributes?

RQ2. Which platform attributes are preferred by the farmers in terms of trade-off concerning price advantages?

To the authors' knowledge, no research has empirically explored the farmers' preferences for agricultural platform design attributes. Further, most studies present the ex-post analysis of agricultural platforms. The uniqueness of this study lies in its attempt to provide an *ex ante* understanding of the farmers' preference for the platform design attributes. In this study, we elucidate the principal attributes that maximize the utility function of digital platforms from farmers' perspectives. Understanding the contribution of an attribute to the composite utility will help the practitioners design and develop the platform that meets the farmers' expectations and attracts them to onboard.

The remaining paper is organized as follows: First, we discuss the study's theoretical background, followed by methods. The next section explains the results and discussion. And the final section concludes the paper with the theoretical and managerial implications of the study.

2. Theoretical background

The agricultural platforms are digital intermediaries comprising a lead firm (generally the fundamental entity controlling or owning the platform), associated complementors (input suppliers, advisory providers, credit providers, technology developers.) and the end-beneficiaries (farmers, cooperative societies or farmer producer organizations) (Cenamor, 2021; Jacobides *et al.*, 2018; Singh and Kapoor, 2023). The objective is to reduce friction and improve efficiency in the exchange between participants (Cusumano *et al.*, 2019; De Reuver *et al.*, 2018). The exchange can be non-economic, such as peer-to-peer exchange of information and knowledge through the social media module or non-monetized free services (such as weather forecast market price of commodities) provided by the platform to anchor the

farmers with the platform and motivate them to engage in economic exchange. The economic exchange includes purchasing agri-input, selling farm produce or paid advisory and farm consultation services, farm credit, agricultural insurance and escrow services (Agyekumhene *et al.*, 2018; Singh and Kapoor, 2023).

A platform can have a discovery value proposition that provides a directory of potential agri-food value networks and reduces search costs (Srinivasan, 2021). Plantix and Samunnati's agri-elevate are discovery platforms operational in India. Agricultural platforms can also provide matching and transaction value propositions to reduce the search cost for all parties involved in the exchange and facilitate the transaction on (transaction platform) or off the platform (matching platform). The Samunnati's Samarambh is a popular agricultural matching platform, while platforms like Dehaat, Agrostar, Bighaat, IFFCO Bazar and Coffee Board of India e-marketplace are transaction platforms (Nafpo, 2022; Nasscom, 2019; Praxis, 2020; Singh and Kapoor, 2023). The platforms are characterized by higher value creation as compared to the traditional pipeline model; the difference arises due to the development of a positive network externality effect and complementarity between the offering of different participating entities (Cusumano *et al.*, 2020).

The extant literature suggests that agricultural inputs and farm supplies are experience and credence goods, where apriori estimation of the product quality parameters is impossible (Dharni and Singh, 2011; Ford *et al.*, 1988; Kumar and Kapoor, 2018). In the traditional pipeline model, the farmer purchases the agri-inputs from the retail stores, and the retail store uses indirect proxies to signal the quality of the product. Usually, the store's reputation and product price are used to signal the quality. There is apparent buyer–seller information asymmetry (BSIA), and the retailer can potentially engage in opportunistic behaviour. An adverse selection problem can occur at the farmers' end (Izquierdo and Izquierdo, 2007).

Further, the farmer incurs a high transaction cost to avail of the farm supplies and services bundle. The transaction cost includes the cost related to information search, farmers' decision-making and other costs needed for the smooth execution of the transaction (Batte and Ernst, 2007). The dual problem of BSIA and high transaction costs is critical to the farmers in developing economies such as India (Senapati, 2020). Digital technologies and platform business models can potentially reduce transaction costs and information asymmetry (Srinivasan, 2021). Batte and Ernst argue that farm inputs with a dispersed consumer base and a high level of informality will be an attractive market for agricultural platform firms (Batte and Ernst, 2007; Omulo and Kumeh, 2020).

Different types of entities have promoted platform firms. For instance, the IFFCO Bazar platform has been promoted by a cooperative entity, the coffee board of India e-marketplace has been promoted by a government entity, and private entities have promoted the Dehaat and Agrostar platforms. Previous studies in extending and disseminating ICT services suggest that public-promoted services are crucial for farmers' welfare. The privately promoted service can provide high-end better-customized service to the farmer (Feder *et al.*, 2011; Goldsmith, 1985; Wuepper *et al.*, 2021). Whether the nature of the platform lead firm can affect the farmer's preference is not evident from the extant literature. Hence it is interesting to explore the relative preference of farmers towards private, government and cooperative agricultural platforms.

The purchase of agri-input and farm supplies has been generally linked with the availability of farm credit. The farmers in developing economies typically receive revenue at the end of the harvest cycle. However, farming operations, agri-inputs and farm supplies continuously require the flow of working capital. The availability of farm credit is directly linked to farm operation decisions (Adjognon *et al.*, 2017; Khandker and Faruque, 2003). If farmers have to purchase the agri-inputs from the platforms and credit is a complementary requirement, the farmers may expect the platform to provide farm credit service. Whether credit availability on the platform will affect the farmers' preference towards the platform is

not clearly understood in the literature. Previous studies on the e-commerce application for crop protection products in developed countries have identified the farmers' preference for a price advantage, prompt delivery and the importance of personal consultation service (Fecke *et al.*, 2018). The same findings will hold for agricultural platforms in developing economies where the farmers have contrasting characteristics such as high-risk aversion tendencies, smaller landholding and the spatially dispersed nature of agrarian commune (Fabregas *et al.*, 2019; Henrich and McElreath, 2002; Tröger *et al.*, 2018).

Qualitative studies on platforms have suggested the critical role of village-level entrepreneurs (VLEs) in contextualization, localization and delivery of the platform services to the grass-roots level, resulting in a self-sustainable business model (Bhaskara and Bawa, 2021; Jha *et al.*, 2016). The face-to-face agro-advisory and consultation service can provide physical contact points in a digital space where trust is pivotal in effectuating a business transaction (Gefen, 2000; Jha *et al.*, 2016; Sarangi *et al.*, 2019; Yang, 2021). Whether the farmers prefer an agricultural platform with VLEs providing agri-advisory and farm consultancy is unexplored in the literature. Finally, the farmers need access to the market to sell their farm produce (Argade and Laha, 2018). A platform with a discovery value proposition can provide a frequently updated directory of prospective produce buyers—the matching platforms can facilitate linking prospective buyers with the seller by utilizing computational filters on specific selected criteria. In comparison, a transaction platform can facilitate real-time nudging and bargaining; eventually, the transacting parties can arrive at a price point and the business transaction can happen (Srinivasan, 2021). The kind of platform the farmers generally prefer is not explored in literature and is worth exploring.

The extant literature explores the adoption of the agricultural platform from the technology determinism school of thought (Qureshi, 2014). The first step in adopting technology is user access, awareness and trust (Davis, 1989; Hanna, 2018; Joshi and Islam, 2018; Mendes *et al.*, 2023). Accordingly, in dominant theory, the platform is developed by the lead firm, and its adoption, as suggested by the TAM, depends on its perceived value, perceived usefulness and perceived ease of use (Davis and Bagozzi, 1989; Gefen *et al.*, 2003; Kabbiri *et al.*, 2018; Soodan *et al.*, 2023). The sociotechnical system literature also provides an alternative perspective describing the adoption of the platform in general, the unified theory of acceptance and use of technology (UTAUT). According to this theory, the platform adoption depends on factors such as facilitating conditions, subjective norms and social influence, effort and performance expectancies (Schuetz and Venkatesh, 2020; Thusi and Maduku, 2020; Venkatesh *et al.*, 2016; Ye *et al.*, 2020). However, these models assume that the firms develop the platform centrally and then users adjust according to the platform. The user-centricity is ignored. In this study, we take an alternative perspective of the social shaping of technology where the platform is configured and designed from the farmers' perspective (Jørgensen *et al.*, 2009). Such a platform should maximize the composite utility function of the platforms for the users.

3. Materials and methods

3.1 Data collection

The data for this study was collected in April 2021 in Rajpur town of Kanpur Dehat district in Uttar Pradesh, India. The experiment was carried out on 126 farmers in nine villages of Rajpur town viz. Damanpur, Gubaar, Khalaspur, Bhal, Jaunpur, Madiyapur, Jallapur, Khas-Bara and Vidhauhi. The nearest agricultural produce market committee (APMC) market yard is Auraiya mandi, and the nearest agri-input stores are located in main Rajpur town. The site for data collection was decided based on the feedback of domain experts and practitioners. The purposive sampling approach was used in data collection. The discrete choice experiment was included in the survey. Only those respondents were invited to participate in

the discrete choice experiment who were aware of and have access to the digital platforms for agri-inputs operational in their town. Since the agri-input platforms are still nascent in India and other developing economies, and the real transaction data from the platform is scarce and challenging to obtain, the discrete choice experiment is an appropriate method for understanding the farmers' preference for the platform attributes (Fecke *et al.*, 2018). The characteristic of the sample is summarized in Table 1.

3.2 Discrete choice experiment

The farmers were invited to participate in the choice experiment voluntarily. They were presented with a set of 16 choice cards, one at a time, each having two alternatives on agricultural platforms. These platforms were constructed as a bundle of six attributes, each having six different levels. A pool of potential platform attributes was created from the existing literature. The list of attributes and their levels was augmented by in-depth interviews with Vidhauri and Khas Bara village farmers. Although the initial collection of attributes was reasonably extensive (with a total of thirteen attributes), finally, six attributes were included in the choice experiment to reduce the complexity of the choice experiment. The empirical choice model used in the study is based on the assumption that the farmers can make a trade-off between different attributes and their respective levels while making a rational choice that maximizes the composite utility function. If a large number of attributes are included in the experiment, then the choice card will become reasonably complex, and there is a risk that the decision made by farmers will not be on this trade-off but some lexicographic cues or heuristics. The literature is ambiguous regarding the exact number of attributes to be included in the discrete choice experiments; however, in most of the studies in agribusiness marketing, the number lies somewhere between three to six attributes. Accordingly, six platform attributes were identified so that the farmers have a fair idea about the agricultural platforms and keep the individual exercise uncomplicated and less confusing.

Description	Mean	Std. Dev	Min	Max
Age (Years)	46.33	16.87	15	85
Percent farmland under commercial crops *	26.21	25.39	0	100
Distance of APMC yard from village (Km)			32	37
Distance of nearest Agri-input store from the village (Km)			1	5
				Percent
<i>Education</i>				
Illiterate				0.00
Grade 1-5				7.94
Grade 6-10 (Upto secondary)				37.30
Grade 11-12 (Senior secondary)				23.02
Graduation and above				31.75
<i>Size of landholding (acres)</i>				
≤2				26.19
2 to < 5				33.33
5 to < 10				28.57
10 to < 20				9.52
20 to ≤ 45				2.38

Table 1.
Characteristic of the sample

Note(s): *Commercial crops includes Mustard, Pea, Potato and Coriander
Source(s): Authors' own based on analysis of data

The final six attributes for the choice experiment were selected based on the garret ranking score obtained from rank data collected from fifteen farmers. The Garret ranking method is based on calculating the percent position score (Manoharan *et al.*, 2003; Thulasiram and Alagumani, 2018).

$$\text{Percent position} = \frac{100(R_{ij} - 0.5)}{N_j} \quad (1)$$

here, R_{ij} is the rank given for the i^{th} attribute by the j^{th} farmers and N_j is the attribute ranked by j^{th} farmers.

Based on the percent position, the mean Garret score was calculated, and the final overall rank of the attributes was determined. Table 2 shows the attribute pool and garret ranking score of the attributes based on which the final list of attributes was drawn and used in finalizing the six attributes used in the final experiment.

The D-efficient design of the choice cards was created using the d-create command in STATA that is based on a modified version of the Fedorov algorithm (Hole, 2016). In the design stage, the coefficients were set to zero to create a hypothetical choice experiment situation (Kolstad, 2011). The final design was fairly orthogonal, had sufficient level balance and had no overlap problem (Appendix: Table A1). The result of the design exercise was a set of sixteen choice cards, each having two alternatives to decide from. Hence each participating farmer made sixteen choices (Appendix: Table A1). The choice cards (Appendix: Figure A1) were randomized for different participants to minimize the effect of learning and fatigue during the experiment. Further, to check that the farmers easily understood the choice cards, a small trial of the choice experiment was conducted on six farmers; and based on their feedback, minor corrections were made in the choice cards, primarily in the language framing of different attributes (These responses were not included in the final analysis). Once the choice cards were finalized, the choice experiment was conducted (Appendix: Figure A1). The Figure 2 summarizes the steps involved in the designing of DCE.

Attributes	Mean Garret's score	Rank	Inclusion in DCE (yes/No)
Ownership of the digital platform	73.20	1	Yes
Maximum credit provided by platform for purchasing agri-inputs and allied services (INR/bigha)	71.13	2	Yes
Connecting farmers with the output buyers	65.33	3	Yes
Time duration to deliver the services (days)	64.40	4	Yes
Price advantage on inputs, information and consumer services (on MRP or open market price)	59.07	5	Yes
Means of providing agricultural information and consultancy	58.47	6	Yes
Local facilitation centre facility available or not	50.20	7	No
Distance of the local facilitation centre from village	38.73	8	No
Reviews of product, services and platform itself on the social media	37.20	9	No
Time lag in receiving the payment of output sold on the platform	36.53	10	No
Number of farmers recommending the platform	32.07	11	No
The minimum amount (Kg) of agri-output that can be sold on facilitation centre	30.07	12	No
Purchase option for buying agricultural inputs (single product or entire bundle of product/services sold for individual crop)	28.53	13	No

Source(s): Authors' own based on analysis of data

Table 2.
The selection of attributes for the discrete choice experiment

3.3 The theoretical model

The final data were analysed using the bootstrap conditional logistic regression model which is consistent with that proposed by McFadden (Kolstad, 2011; McFadden, 1974). The method is based on the random utility theory and the principal assumption of the farmers' rational economic decision-making and utility maximization behaviour. The overall utility is a composite function of the platform attributes' individual utility (Mangham et al., 2009). The choice of logistic regression model is based on the argument that the farmer, n , which we assume to be a rational person, while making a choice among J platforms alternative, then she/he will choose a platform i over the platform j such that that the composite utility of the i platform is higher than the composite utility j (Kolstad, 2011; Terris-Prestholt et al., 2019; Weber, 2021). This can be expressed as:

$$U_{ni} \geq U_{nj} \tag{2}$$

The farmers actual utility of the platform alternative cannot be directly determined, only the representative utility function V_{nj} can only be observed by the researcher and ϵ_{nj} is the remaining random and unobservable component.

$$U_{nj} = V_{nj} + \epsilon_{nj} \forall j \tag{3}$$

As per the McFadden method (McFadden, 1974) for logistic choice probability of choosing the platform i over j can be expressed as:

$$P_{ni} = \Pr(V_{ni} + \epsilon_{ni} > V_{nj} + \epsilon_{nj} \forall i \neq j) = \Pr(\epsilon_{nj} < \epsilon_{ni} + V_{ni} - V_{nj} \forall i \neq j) \tag{4}$$

The underlying assumption is that the farmers have a mental preference for all the platform attributes and their respective level and the selection of the alternative platform in a choice card is based on their overall rational behaviour of utility maximization.

The utility of the n th farmer associated with the platform can be expressed as:

$$U_n = V_n + \epsilon_n = \alpha_1 + \beta_1 x_{1n} + \beta_2 x_{2n} + \dots + \beta_m x_{mn} + \epsilon_n \tag{5}$$

The corresponding β , are the coefficient for each attribute levels. In the logistic regression model the likelihood of farmer choosing platform i can be expressed as:

$$P_i = \frac{\exp(V_i)}{\sum_{j=1}^N \exp(V_j)} \tag{6}$$

The farmers' willingness to accept (WTA) was calculated as their willingness to accept more price advantage to have an improvement in any other attributes of the platform, which can be expressed as follows:

$$WTA(Attribute_i) = -\frac{\frac{\partial U}{\partial}(Attribute_i)}{\frac{\partial U}{\partial}(Price\ advantage)} \tag{7}$$

Figure 2. Steps involved in designing the discrete choice experiment



Source(s): Authors' own conceptualisation based on review of literature

The Attribute i is the attribute in which the improvement is calculated relative to the price advantage. The conditional logistic regression was bootstrapped to reduce the standard error and accurate estimation of the parameters. A random seed number (36) was used, and the resampling was performed 375 times to arrive at the final model. The DCE allows us to understand the significance of the particular attribute and the extent to which the farmers are willing to prefer it over the other attribute. The learnings about the attribute can help scholars and practitioners to feature the selected attributes in the platform design. The list of attributes and their level used in this study are summarized in [Table 3](#).

4. Results and discussions

The bootstrap conditional logistic regression findings ([Table 4](#)) suggest no significant difference in farmers' preference for the government-owned or cooperative-owned platforms; however, the private-owned platforms are significantly less preferred than the

Level codes [§]	Ownership of the digital platform/Key entity which controls the platform	Attributes				
		Maximum credit provided by the platform for purchasing agri-inputs and allied services (INR/ bigha)	Time duration to deliver the services (days)	Means of providing agricultural information and consultancy	Price advantage (on MRP or open market price)	Connecting farmers with the output buyers
0	Cooperative	4,000	2	Call centre representative	0%	The platform provides a commodity-wise list of nearby output buyers with contact details
1	Government	6,000	5	Digitally by the user interface	10%	The platform has an integrated feature of connecting the farmers with the nearest output buyer
2	Private	8,000	7	Face-to-face through a local facilitation centre	20%	The platform digitally connects the farmers with buyers and provides a mechanism for price negotiation and bargaining

Note(s): [§]The dummy coding (0/1) method was used in the analysis

Source(s): Authors' own based on analysis of data

Table 3.
The final attributes and levels selected for conducting the discrete choice experiment

Variable	Coeff	Bootstrap std. err	Odds ratio	WTA [#]	Lower level of 95% C.I.	Upper level of 95% C.I.
Private-owned platform ^a	-0.3439 ^{***}	0.075	0.709	21.968	9.886	34.050
Cooperative-owned platform ^a	0.00731	0.075	1.007	-0.467	-9.932	8.998
Credit facility	0.00008 ^{***}	0.000	1.000	-0.005	-0.008	-0.002
Time duration to deliver product/service	-0.06129 ^{***}	0.015	0.941	3.914	1.250	6.578
Consultancy and farm advisory service through VLE ^b	0.50852 ^{***}	0.076	1.663	-32.475	-49.559	-15.391
Consultancy and farm advisory service through call centre ^b	-0.04056	0.074	0.960	2.590	-6.734	11.915
Price advantage on agri- inputs and information	0.01566 ^{***}	0.004	1.016			
Developing market linkages and bargaining for crop output through platform ^c	0.23608 ^{***}	0.065	1.266	-15.077	-26.101	-4.052
List of market linkages for crop output ^c	-0.51723 ^{***}	0.070	0.596	33.032	16.707	49.356
Number of farmers	126					
Number of observations	4,032					
Wald χ^2 (10)	273.4200					
Prob > χ^2	0.0000					
Pseudo R2	0.1119					
Log-likelihood	-1241.025					
Note(s): * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$						
[#] WTA is the willingness to accept (higher expected price advantage) for improvement in other platform attributes. The confidence intervals are calculated using the delta method (nlcom command in STATA 14)						
^a Relative to the government-owned agricultural platform. ^b Relative to the digital-assisted consultancy and agro-advisory. ^c Relative to the platform providing only the digital linkage between produce buyer and farmer						
Source(s): Authors' own based on analysis of data						

Table 4. The estimations of the bootstrap conditional logistic model and WTA estimates

government-owned platforms. There is a clear preference for the platform providing higher farm credit for purchasing the agri-inputs; however, the overall impact on the farmers' observed utility is very small but significant. The higher preference of farmers towards the agricultural platform providing credit can be explained by the network externality theory (Katz and Shapiro, 1985; Omar *et al.*, 2023; Parker and Van Alstyne, 2005). Including banks or financial institutions in the platform increases the diversity of complementors which can increase the indirect network externality. Hence, the utility of such a platform improves for the farmers.

The farmers also prefer a platform with a lesser service lag time, i.e. they expect the platform to deliver products or services promptly. The findings suggest no difference between digital consultancy and call centre-based consultancy and advisory services; however, the farmers have a higher preference for face-to-face consultancy (through village-level micro-entrepreneurs). The farmers have preferred a platform with a higher price advantage. Further, there is no significant difference in the farmer's preference for a platform providing a directory list of output buyers (discovery value proposition) or digitally connecting with the farm produce buyer (matching value proposition). The farmer has a significantly higher preference for the platform, which allows them to negotiate and bargain with the farm produce buyers (matching and transaction value proposition).

The findings suggest that the ownership of the platform (or promoting entity) also affects the farmers' decisions. This may be due to the higher risk-averse nature of the farmers in developing economies (Hardman *et al.*, 2002; Henrich and McElreath, 2002; Jakku *et al.*, 2019; Pollard, 2003; Tudor *et al.*, 2014). Government entities are generally more trusted (Wuepper *et al.*, 2021). Further, the agriculture cooperative entities, especially the like of the Indian Farmers Fertilizer Cooperative Organization (IFFCO) and Krishak Bharti Cooperative Organization (KRIBHCO), have local village-level cooperative societies in which the farmers are the direct members and shareholders. They have been present in Indian villages for a few decades and have started digital platforms after completing the long phase of social intermediation. Agricultural platform having government and/or cooperative entities as a partner along with private firms is more likely to be trusted by the farmers (Feder *et al.*, 2011; Goldsmith, 1985). Hence, the platform firms should integrate such entities as complementor on their platform.

The purchase of agri-inputs has been associated with agriculture credit; the farmers usually purchase inputs by taking credit from the retailer or banks or using the Kisaan credit card promoted by the Indian government. To promote an agri-input platform, the lead firm should try to integrate modules of a bank/non-banking financial company/or any other similar firm to lend instant and need-based credit to the farmers; the appropriate mechanism of providing such facility should be carefully worked out (Adjognon *et al.*, 2017; Khandker and Faruquee, 2003). The farmers also consider the platform's lead time of service delivery as a crucial factor in adopting the platform (Fecke *et al.*, 2018). This is due to the time-specific need for agricultural inputs, especially the seed, pesticides, micro-nutrients and fertilizers; since the farming operations are highly time-specific, the utility window of a product is very narrow if the lead time offered by the platform is very high, then it may overshoot the utility window. The farmer seeks to purchase the product from the alternative market (physical retail stores) in case of temporal delay from the platform.

The findings have also suggested the higher preference of farmers towards the face-to-face consultation provided by village-level micro-entrepreneurs since it becomes a direct point of contact between the farmer and the platform, can handhold the farmers while using the platform, deliver the context-specific services and reduce the overall risk perception of the farmer (Jha *et al.*, 2016; Sarangi *et al.*, 2019; Yang, 2021). The call centre or digital consultation may not bridge the gap between the platform and a risk-averse smallholder. The farmer also expects a price advantage on the platform offerings; this finding aligns with the other studies on e-commerce in developed economies (Fecke *et al.*, 2018; Singh *et al.*, 2019). Finally, the results suggest a higher preference of farmers towards the platform providing a mechanism to connect and negotiate the price with the prospective farm produce buyers. This value proposition of the platform is known as matching and transaction facilitation in the digital economy literature (Srinivasan, 2021).

5. Conclusion and implications

With the conducive environment for technology adoption in the agriculture sector in all the developing countries, including India, several digital platforms are in operation (Krishnan *et al.*, 2020; Nasscom, 2019; Praxis, 2020). However, at the inception stage, these enterprises face the issue of onboarding a large number of farmers to undertake business transactions (Jha *et al.*, 2016; Mishra *et al.*, 2009; Singh *et al.*, 2019). Keeping this challenge in focus, the present research identifies the farmers' preferences for the attributes of agribusiness platforms which can improve the overall utility of the platform for the farmers and improve its adoption, especially by spatially dispersed farming communities having small landholding. The present empirical study is based on data collected from 126 farmers located in the state of Uttar Pradesh in India. The data was collected using the discrete choice experiment methodology, and the results were computed through the bootstrap conditional logit regression technique.

The study suggests that the farmers have a lower preference for the purely private-owned digital platform and hence expect a higher price advantage when compared to the government-owned digital platforms. Since a large number of private entities are entering the agri-tech space, they should attempt to partner with the government entities or cooperative institutions since these institutions can induce the element of trust among the risk-averse farmers. Cooperative bodies like IFFCO and KRIBHCO are more trusted because they have been associated with the farmers for very long, and the process of social intermediation is deeply rooted in these firms. We propose that social intermediation should precede technological intermediation; platform firms will benefit from partnering with these entities.

If the platform provides agricultural credit, the farmers are more likely to forgo the price advantage. The farmer has a lesser preference for the platform with a higher average lead time of service delivery, which is evident from the high expected priced advantage. If a platform provides face-to-face consultation through local village level micro-entrepreneurs, the farmers, in general, are willing to forgo the price advantage. Further, if the platform provides a facility of matching the farmers with the prospective farm produce buyer and provides a bargaining mechanism, the farmers are more likely to forgo the price advantage. From the WTA analysis (Table 4), it is evident that the face to face consultation assisted by a VLE and platform assisted selling of farm produce and linked bargaining facility are more preferred attributes of the agriculture platforms. The pure private platforms and the platform merely providing a directory of output buyers are the least preferred attributes. The finding suggests that the farmers expect an agricultural platform to not restrict to being a mere discovery platform providing a directory and contacts detail, but it should provide matching and transaction value proposition as well.

The understanding of the farmers' preference for these platform attributes can potentially help the managers and policymakers in the designing of the agricultural platforms which meets the expectation of the farmers so that they derive higher utility out of it, resulting in higher adoption (Figure 3). Although the present study identifies the nature of lead firms and type of complementors (credit providers, hyperlocal logistic partners, farm produce buyers and VLE), it should be associated with exploring the nature of the contract between partnering entities, mode of integration (modular or non-modular) and the possible governance mechanisms in such innovative agricultural platforms remains unexplored and can be an interesting direction for the future research.

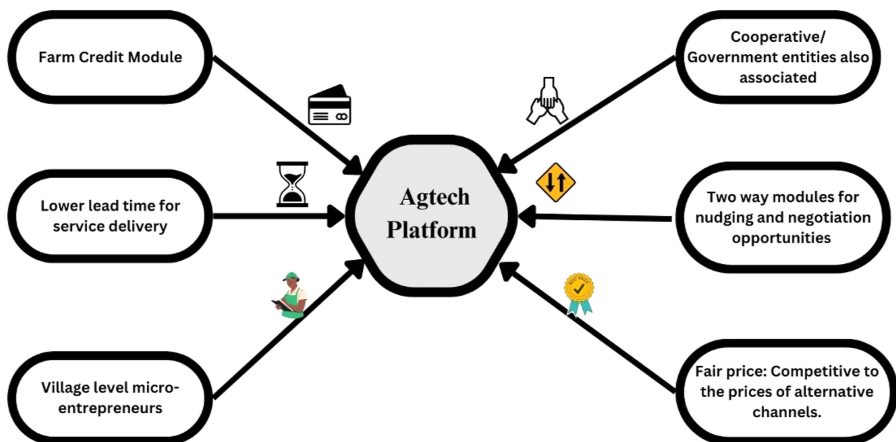


Figure 3. The framework for configuring an agricultural platform for smallholders in the developing economies

Source(s): Authors' own based on analysis of data

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(The Appendix follows overleaf)

S.No	Owner [*]	Credit	Time	Consult	Price	Output	Choice card	Alt
1	2	0	0	0	0	0	1	1
2	0	1	2	1	2	2	1	2
3	0	1	1	0	1	1	2	1
4	2	2	0	1	2	2	2	2
5	2	1	0	2	2	2	3	1
6	1	0	2	1	1	0	3	2
7	0	2	0	0	2	1	4	1
8	2	1	1	1	1	2	4	2
9	1	0	0	2	1	2	5	1
10	2	2	2	0	0	0	5	2
11	2	0	1	1	2	1	6	1
12	1	1	2	0	1	2	6	2
13	2	2	1	0	1	2	7	1
14	1	1	0	1	0	1	7	2
15	2	1	2	1	2	1	8	1
16	1	2	1	2	0	2	8	2
17	1	0	2	0	2	2	9	1
18	0	2	1	2	1	1	9	2
19	2	1	0	1	0	0	10	1
20	1	2	2	2	2	1	10	2
21	0	2	0	1	2	0	11	1
22	2	0	2	2	0	1	11	2
23	0	0	1	0	0	2	12	1
24	2	2	2	2	1	0	12	2
25	1	2	1	0	0	1	13	1
26	0	0	0	2	1	0	13	2
27	1	1	1	0	2	0	14	1
28	0	2	2	1	0	2	14	2
29	0	0	2	2	2	0	15	1
30	1	2	0	1	1	1	15	2
31	1	1	1	2	0	0	16	1
32	2	0	0	0	1	1	16	2

Table A1.

The development of choice cards by using a d-efficient design[#]

Note(s): [#] One choice card has two alternatives

* 0,1,2 are the level code (dummy coding was used)

Source(s): Authors' own based on analysis of data

Choice_set	1	1
Alternative	<i>a</i>	<i>b</i>
Owner/ Key player of the platform	Private firm owned	Cooperative owned
Maximum Credit offered per bhiga	4000	6000
Maximum service time in days	2	7
Mode of farm consultation and agri-advisory	Call center representative	Digitally by messaging or video call
Price advantage on agri-input and information	0%	20%
Type of market linkage for crop output	The platform provides a commodity wise list of output buyers with contact details	The Platform connects the farmers with buyers and provide a mechanism of price negotiation bargaining

Your Choice



Source(s): Authors' own based on analysis of data

Figure A1.
Example of a choice
card used in the
discrete choice
experiment

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